PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :		(11) International Publication Number: WO 93/17561
A21D 2/22, 8/02, A21C 1/00	A1	(43) International Publication Date: 16 September 1993 (16.09.93)

(21) International Application Number: PCT/GB93/00471

(22) International Filing Date: 5 March 1993 (05.03.93)

(30) Priority data:
9204883.4 5 March 1992 (05.03.92) GB

(71) Applicant *(for all designated States except US)*: APV CORPORATION LIMITED [GB/GB]; Manor Drive, Paston Parkway, Peterborough PE4 7AP (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : COLLINS, Thomas, Hylton [GB/GB]; 7 Yarrowside, Little Chalfont, Buckinghamshire HP7 9QL (GB).

(74) Agents: SHERRARD-SMITH, Hugh et al.; Appleyard Lees, 15 Clare Road, Halifax, West Yorkshire HX1 2HY (GB).

(81) Designated States: AU, JP, NZ, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: DOUGH MIXING

(57) Abstract

The invention relates to a dough mixing method for use in breadmaking, which comprises mixing together dough ingredients, including ascorbic acid as an improver, in the presence of air or an oxygen-containing gas. The mixing provides sufficient mechanical energy for a sufficient time to develop the gluten in the dough. Excess pressure is applied to the atmosphere around the dough during a first phase of the mixing, and then a reduced pressure is applied during a second phase. Apparatus for carrying out the method is also provided.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria
AU	Australia
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CS	Czechoslovakia
CZ	Czech Republic
DE	Germany
DK	Denmark
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IT	Italy
JP	Japan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakhstan
LI	Liechtenstein
LK	Sri Lanka
LU	Luxembourg
MC	Monaco
MG	Madagascar
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SK	Slovak Republic
SN	Senegal
SU	Soviet Union
TD	Chad
TG	Togo
UA	Ukraine
US	United States of America
VN	Viet Nam

DOUGH MIXING

This invention relates to dough mixing, and in particular to improvements in dough mixing to maximise the utilisation of ascorbic acid as a bread improver.

The baking industry makes use of improvers for the control of loaf quality and to enable better production of bread using fast processes in modern highly mechanised plants. The use of improvers is not exclusive to large scale production, though the subject of this invention applies more to large scale than any other.

On 1st April 1990 permission to continue to use the improver potassium bromate was withdrawn by the U.K. Government. A similar action has either already taken place in other developed countries or could do so in the foreseeable future.

Bromate was a very versatile improver, acting under all the conditions commonly in use for breadmaking. In particular, it did not require to be converted into another compound to work as an improver, it was unaffected by the atmosphere in the mixing machine bowl and there was synergism between it and ascorbic acid, the other most widely used improver.

The U.K. baking industry now has a choice of only three oxidising improvers, ascorbic acid, azodicarbonamide and chlorine dioxide (a gas treatment used only occasionally at the end of flour milling). Ascorbic acid, which is vitamin C, is the preferred improver, it is the only improver allowed in many countries, including all of the EC. However, it has characteristics which are difficult to deal with in some breadmaking circumstances.

During mixing air is incorporated into the dough, and the oxygen in the air converts the ascorbic acid to dehydroascorbic acid, which is the true oxidising improver. Industrial bakers now have breadmaking problems which are caused by insufficient improvement from ascorbic acid. Though azodicarbonamide is an alternative to ascorbic acid, it is generally less acceptable to consumers and more difficult to control in the bakery because of its rapid and powerful improver action. Some bakers choose not to use azodicarbonamide. Improver chlorine dioxide is very weak, cannot be applied at the bakery and could not, on its own, provide all the improver function required.

The consequences of sub-optimal oxidising improver action are lower loaf volume, increased firmness of the whole loaf and slice (interpreted by consumers as staleness), duller crumb colour and less acceptable eating quality. The extent of the problem is widespread within the UK and will affect breadmaking in all countries using rapid processes with ascorbic acid as the only improver. It is of particular importance where loaf crumb structure is required to be uniform.

In modern breadmaking processes mixing is much more than the homogenous incorporation of the recipe ingredients into a dough. During dough mixing there are three essential factors which must occur simultaneously, as follows:

1. There must be mechanical energy expended at an intensity which is sufficient to develop gluten derived from both the natural protein in flour and from any dried gluten added to raise the flour performance. A high speed, highly powered mixing

machine is required with the ability to impart an energy level of about 11Wh/kg of dough. To be effective the intensity of mixing must impart the required work input in a total mixing time not exceeding about 4 minutes. This mixing machinery is commonly available and used to produce about 80% of all bread made in the UK. Similar machines are in use in about 30 countries.

2. During mixing air must be mixed into dough to create bubble nuclei and to provide oxygen which is essential for the conversation of ascorbic acid to dehydroascorbic acid (the true oxidising improver). The oxidising improver gives stability to gluten development. The mixing action is required to both beat air in and subdivide it into a uniform structure of very small cells. Oxygen from the air in the dough bubbles is quickly removed by yeast in the recipe, which leaves nitrogen gas to nucleate the structure. The nitrogen bubbles in dough are expanded as carbon dioxide produced by yeast fermentation diffuses into them. When the expanded structure is set during baking it becomes the crumb structure of the loaf.

3. The correct subdivision of air in dough during mixing, required to produce a uniform loaf structure acceptable for most breads, is essential but difficult to achieve. It is substantially more successful when a partial vacuum is applied during mixing. This produces bubbles of smaller diameter which have greater stability during subsequent machining. The application of a partial vacuum removes air which in turn decreases oxidation from ascorbic acid and adversely affects oxidising

improvement required for dough development and bubble structure stability.

Restricting air incorporation during mixing, by applying a partial vacuum, did not matter when bromate and ascorbic acid could be used together. It is a problem when ascorbic acid is on its own. Bakers now have loaf volume and structure problems caused by insufficient oxidation from the improver. Bakers try to cover-up these loaf problems by the use of more expensive higher protein flour, adding emulsifier, increasing enzyme addition and sometimes by taking all three of these measures. However, these measures do not provide a satisfactory solution to the problem.

It is known that improver action from ascorbic acid can be increased by delaying the application of partial vacuum until about the second half of mixing. That means mixing at atmospheric pressure for about 2 minutes and pulling partial vacuum for the remainder of the time until the required work input has been achieved, approximately a further 2 minutes in a large size machine. Structure control is not quite as good as when there is partial vacuum throughout mixing, but oxidising improver action is better, though less than optimum.

The present invention provides a solution to the problem outlined above by the application of a pressure/vacuum sequence to provide adequate air in the atmosphere during the first phase for ascorbic acid conversation to dehydroascorbic acid, followed by rapid application of partial vacuum for bubble structure control.

The invention thus provides a dough mixing method for use in breadmaking, which comprises mixing together dough ingredients, including ascorbic acid as an improver, in the presence of air or an oxygen-containing gas, the mixing providing sufficient mechanical energy for a sufficient time to develop the gluten in the dough, characterised in that excess pressure is applied to the atmosphere around the dough during a first phase of the mixing, and then a reduced pressure is applied during a second phase.

The invention also provides apparatus for carrying out the above method, comprising a mixing chamber having a mixing element and a lid which is movable between open and closed positions, the lid being capable of making sealing contact with the chamber when in the closed position, characterised in that means are provided for successively applying excess pressure and then reduced pressure to the interior of the mixing chamber when the lid is closed.

The mixing machine bowl is a pressure vessel also capable of withstanding a high partial vacuum. External to the mixing chamber is another pressure/vacuum chamber with a valve connecting it to the mixing vessel.

In operation the external pressure vessel is pressurised while the mixing vessel is loaded with ingredients. At the start of mixing, pressure from the external pressure vessel is transferred to the mixing machine bowl for the first part of mixing to encourage oxidising improvement from ascorbic acid. While this is taking place the external vessel creates a partial vacuum enabling rapid change-over in the mixing vessel from pressure to partial vacuum to create the desired bubble

structure. After transfer of vacuum the external vessel is again pressurised and so on.

The invention enables better improvement from ascorbic acid, resulting in maximum performance of flour properties, and control of bubble structure. Further exploitation of partial vacuum, which under these combined conditions could be used at lower pressure to further improve dough machining and handling properties, may be possible.

A preferred method of mixing is to operate the mixing elements in opposite directions during the pressure and vacuum stages. During the pressure stage, mixing action should beat air into the dough structure by having a wide face to the mixing element moving into the dough. During the vacuum stage the leading edges of the mixing element have a cutting action to subdivide and open large bubbles for air removal by vacuum.

The invention can also be used with other gases and combinations of oxygen and air to provide higher oxygen concentration in the mixing machine headspace, already known to be successful at atmospheric pressure.

Reference is now made to the accompanying drawings, in which:

Figure 1 is a diagrammatic representation of one embodiment of apparatus for use in the present invention; and

Figure 2 is a diagrammatic representation of another embodiment of apparatus for use in the invention.

Figure 1 shows a mixer bowl 1 provided with a reversible beater drive 2. The bowl is provided with a lid 3 which can be opened for the entry and removal of mixing ingredients. In the closed position, the lid is sealed to the rim of the bowl so that the bowl then becomes a pressure/vacuum-tight container. The bowl 1 is provided with first and second pipelines 4 and 5 respectively. The first pipeline 4 is provided with an adjustable pressure relief valve 6 which is adapted to release pressure from the bowl if it rises above a safe limit. The pipeline 5 is provided with a valve 7 and communicates between the interior of the bowl 1 and a pressure/vacuum tank 8. The tank 8 is in turn provided with a pressure/vacuum supply 9.

In use, the dough ingredients are placed in the bowl 1 and the lid 3 is sealed. The tank 8 has previously been placed under pressure, and the valve 7 is opened to increase the pressure in the bowl 1. The valve 7 is then closed, and the dough ingredients are mixed in the bowl 1 by the beater. In the meanwhile, the tank 8 is evacuated. After a suitable time interval, while mixing in the bowl 1 is continued, excess pressure is released through the valve 6. The valve 6 is then closed and the valve 7 is opened to reduce the pressure in the bowl 1. The valve 7 is closed and the tank 8 is returned to atmospheric pressure. After completion of mixing, the valve 7 is opened to return the interior of the bowl 1 to atmospheric pressure. The lid 3 is opened and the mixed dough is removed.

When the pressure in the bowl 1 is changed from excess pressure to reduced pressure, the direction of rotation of the beater drive 2 is reversed. The blades of the beater have thick edges on one side and narrow cutting

edges on the opposite side. During the excess pressure phase, the thick edges are the leading edges. During the reduced pressure phase, the thin edges are the leading edges.

The apparatus shown in Figure 2 is generally similar in construction and operation to that of Figure 1, and corresponding members have the same reference numerals. However, in Figure 2, a pressure/vacuum tank is not employed, and instead the pipeline 5 communicates directly with a vacuum/pressure device 10 which is capable of increasing pressure or pulling a vacuum directly to the interior of the mixer bowl 1.

The invention is further illustrated by the following example of breadmaking by the Chorleywood Bread process (CBP) adapted according to the present invention.

EXAMPLE

Breadmaking process:	CBP
Bread type:	800g, white, four-piece, lidded, long-loaf.
Mixing machine:	High-speed.
Recipe:	% of flour weight
Flour	100
Yeast	2.5
Salt	2.0
Water	62.0
Fat	1.0
Improver	1.0
Dough processing:	
Mixing machine:	High-speed
Work input:	Up to 11 Wh/kg
First stage of mixing	
Pressure:	Up to 3 Bar, typically 1.5 to 2.0 Bar
Mixing element:	Direction for beating in air preferred
Second stage of mixing	
Pressure:	Partial vacuum, typically 0.5 to 0.25 Bar
Mixing element:	Direction to cut through dough preferred
Dough temperature:	30.5 +/- 1°C
Scaling:	850 to 930g
First moulding:	Into a Ball by Conical moulder
First proof:	2 to 6 min at ambient temperature
Final:	Four-piece
Pan size:	Approx Top 250mm x 122mm, 125mm deep
Shape:	Lidded
Proving conditions:	About 43°C, humidity to prevent skinning
Proving height:	About 2cm below pan lip
Baking temperature:	Average 240 to 250°C
Oven type:	Various
Baking time:	18 to 30 min
Baking humidity:	Steam injected as required
Cooling:	)As appropriate for the variety
Storage:	)

CLAIMS

1. A dough mixing method for use in breadmaking, which comprises mixing together dough ingredients, including ascorbic acid as an improver, in the presence of air or an oxygen-containing gas, the mixing providing sufficient mechanical energy for a sufficient time to develop the gluten in the dough, characterised in that excess pressure is applied to the atmosphere around the dough during a first phase of the mixing, and then a reduced pressure is applied during a second phase.

2. A method according to claim 1, in which the total energy provided by the mixing is from 5 to 20 Wh/kg of dough over a total mixing time of from 1 to 6 minutes.

3. A method according to claim 1 or 2, in which the first and second phase of mixing each last for 1 to 3 minutes.

4. A method according to any of claims 1 to 3, in which the pressure applied during the first phase is in the range of from 1.05 Bar to 3.0 Bar.

5. A method according to any of claims 1 to 4, in which the pressure applied during the second phase is in the range of from 0.5 Bar to 0.25 Bar.

6. A method according to any of claims 1 to 5, in which ascorbic acid is the sole oxidising improver in the dough and the mixing is carried out in the presence of air.

7. Apparatus for carrying out a method according to any preceding claim, comprising a mixing chamber having a mixing element and a lid which is movable between open and

closed positions, the lid being capable of making sealing contact with the chamber when in the closed position, characterised in that means are provided for successively applying excess pressure and then reduced pressure to the interior of the mixing chamber when the lid is closed.

8. Apparatus according to claim 7, in which the mixing chamber is in communication with a pressure/vacuum chamber by way of a valve means, whereby, by opening the valve means, pressure in the mixing chamber can be increased or vacuum obtained, and then maintained in the mixing chamber by closing the valve means.

9. Apparatus according to claim 7 or 8, in which the mixing element is a rotatable shaft having stirrer blades with a relatively wide edge on one side and relatively narrow edge on an opposing side, and the direction of rotation is reversible, so that the leading edges of the blades during mixing can be selected to be relatively wide or relatively narrow.

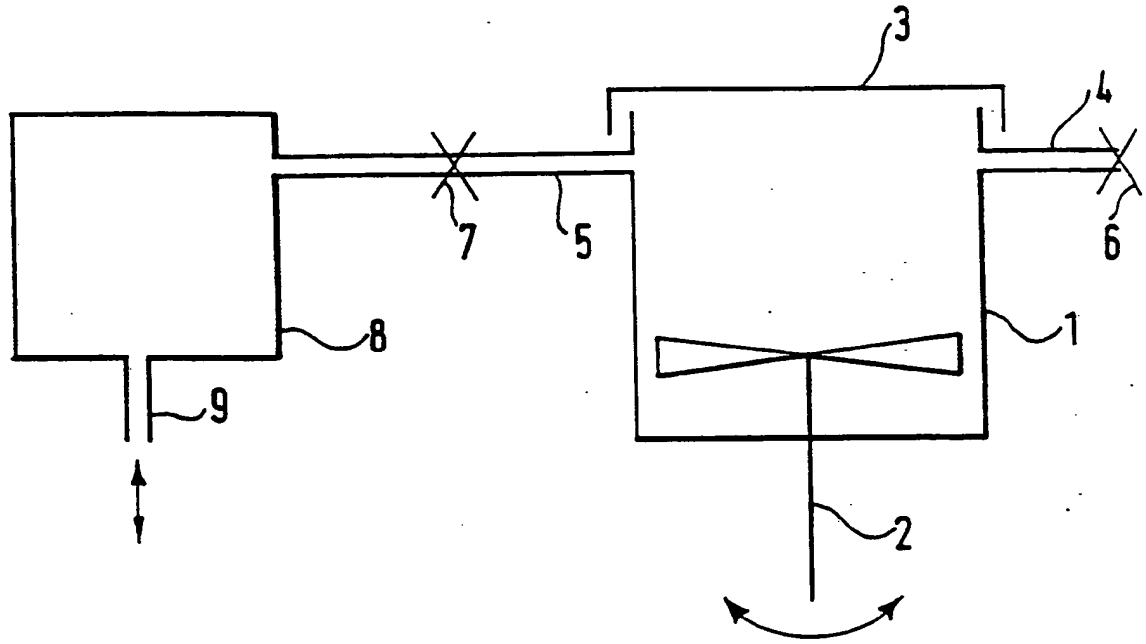

Fig.1.

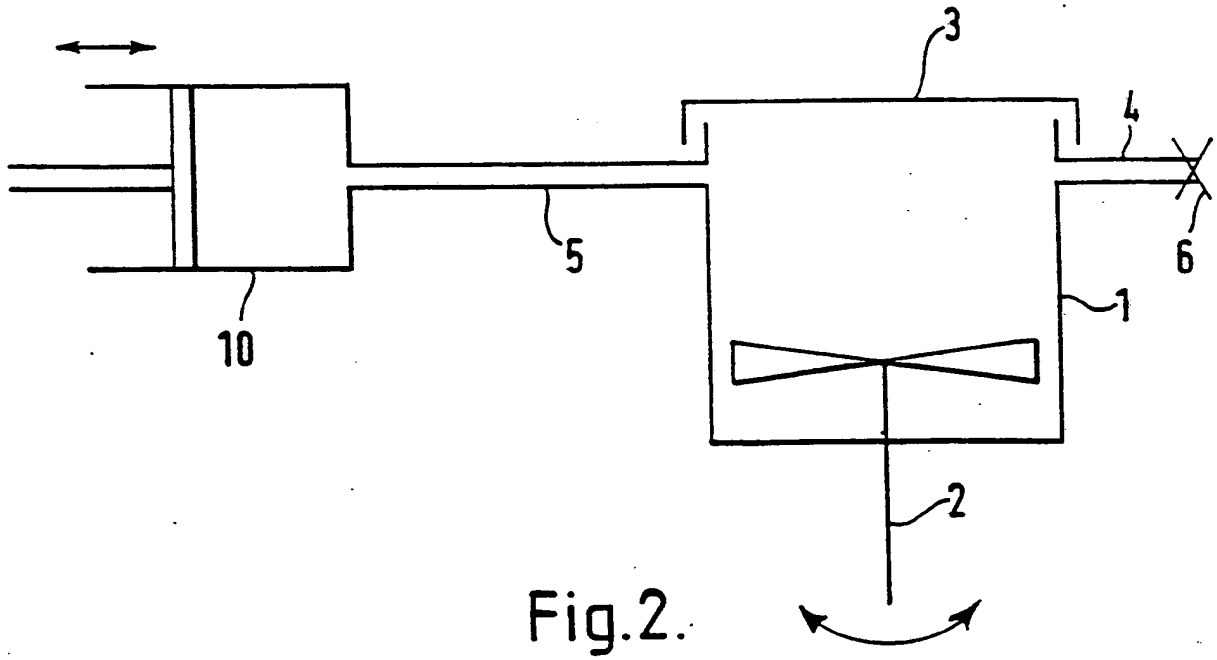

Fig.2.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00471

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 A21D2/22; A21D8/02; A21C1/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	A21D ; A21C ; B28C ; B01F

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
Y	EP,A,0 246 768 (THE BOC GROUP PLC) 25 November 1987 see column 6, line 31 - column 6, line 44; claims	1-3,6-8
Y	GB,A,1 044 616 (G. & R. GILBERT LIMITED) 5 October 1966 see the whole document	1-3,6-8
A	US,A,4 465 700 (K.M.J. BALL) 14 August 1984 see column 4, line 38 - column 6, line 68; claims; figures 6-7	1-3,5, 7-9
A	GB,A,931 637 (F.J. SUNTHEIMER) 17 July 1963 see claims	1,4,7

-/--

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
05 JULY 1993	- 7. 07. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	BEVAN S.R.

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	GB,A,1 110 407 (GEORGE TWEEDY & COMPANY LIMITED) 18 April 1968 see the whole document ---	1,5,7
A	GB,A,2 056 293 (AMSTED INDUSTRIES INC.) 18 March 1981 see figure 3 -----	9

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9300471 SA 71924

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 05/07/93
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0246768	25-11-87	AU-B- 602897	01-11-90
		AU-A- 7316087	26-11-87
		CA-A- 1306247	11-08-92
		DE-A- 3782453	10-12-92
		JP-A- 63032436	12-02-88
GB-A-1044616		None	
US-A-4465700	14-08-84	None	
GB-A-931637		None	
GB-A-1110407		None	
GB-A-2056293	18-03-81	None	